Measuring the equilibrium effects of unemployment benefits dispersion

van Vuuren, A.P.; van den Berg, G.J.; Ridder, G.

1999

Faculteit der Economische Wetenschappen en Econometrie

Serie research memoranda

Measuring the Equilibrium Effects of Unemployment Benefits Dispersion

Aico van Vuuren
Gerard J. van den Berg
Ceert Ridder

Research Memorandum 1999-43

October 1999

/a/l/e/r/t/

applied
labour
economics
research
team

vrije Universiteit amsterdam

Measuring the Equilibrium Effects of Unemployment Benefits Dispersion

Aico van Vuuren *

Gerard J. van den Berg †

Geert Ridder ‡

September **15, 1999**

Abstract

We analyze the impact of unemployment benefits and minimum wages using an equilibrium search model which allows for dispersion of benefits and productivity levels, job-to-job transitions, and structural and frictional unemployment. The estimation method uses readily available aggregate data on marginal distributions of unemployment durations as well as wages and benefit levels. Different causes of structural and frictional unemployment are investigated. We investigate the efficiency of the imposition of a single benefit level for all household types and the introduction of an Earned Income Tax Credit.

*Department of Economics, Vrije Universiteit Amsterdam. Address: De Boelelaan 1105, NL-1081 HV Amsterdam, The Netherlands. E-mail: vuuren@tinbinst.nl, fax: +3120-4446005, phone: +3120-4446120.

†Department of Economics, Vrije Universiteit Amsterdam, Tinbergen Institute and CEPR.

‡Department of Economics, Johns Hopkins University.

Keywords: Equilibrium search, wages, benefit levels, minimum wages, welfare.

JEL classification: 564, C41, E24, 531.

We thank Audra Bowlus, Maarten Lindeboom, and participants at the Journal of Applied Econometrics Conference on Inference and Decision Making, in particular our discussant John Rust, for very useful comments.

1 Introduction

Unemployment benefits and minimum wages are important determinants of the distributions of unemployment durations and wages. There have been many studies on the effectiveness of benefits and minimum wages as policy tools to influence unemployment (see references below). In this study we develop and apply a novel approach to the empirical analysis of the effects of changes in benefits and minimum wages. This approach is attractive for a number of reasons, notably *(1)* it is based on a structural model of optimal decision making of individual agents, *(2)* the model is an equilibrium model of the labor market, *(3)* it allows for the simultaneous analysis of changes in benefits and minimum wages, and *(4)* it only requires readily available aggregate data.

The economic model is a model of labor markets with imperfect information, where workers and employers search optimally for a suitable match. Such models are well-adapted to explain unemployment durations and wages (see surveys by Mortensen, 1986, and Mortensen and Pissarides, 1999) and they allow for non-trivial effects of minimum wages and benefits. To explain the advantages of our model and empirical approach, it is useful to briefly summarize the empirical literature on equilibrium labor market search to date. By now, the empirical analysis of partial search models, which focus on worker behavior and treat the wage offer distribution as given, is widespread. Such models are able to explain many stylized facts (see e.g. surveys by Devine and Kiefer, 1991, Layard, Nickell and Jackman, 1991, and Wolpin, 1995). However, a number of important issues can not be analyzed with these partial models. This of course includes all research issues related to wage determination, employer behavior, interaction between worker and employer behavior, and the effects of policies that directly or indirectly affect wages. All of the latter issues are potentially of great importance for the analysis of the lower end of the labor market and for policy analysis of benefits and minimum wage effects. For instance, an important question as the effect of unemployment benefits on job search by the unemployed cannot be answered satisfactorily without allowing for the possibility that employers respond to changes in the behavior of job seekers.

In response to these disadvantages, equilibrium search models have been developed in which the employers' decision problem is explicitly incorporated. Diamond (1971) shows that, in an economy where both workers and firms are homogeneous, with no possibility for workers to search while employed, the resulting equilibrium wage distribution is a mass point at the wage prevailing if labor demand is monopolized (which is the workers' opportunity cost of employment).

In the general case, equilibrium wage offers must equal the reservation wage of some (group of) worker(s). Intuitively, this is because otherwise a firm can reduce its wage offer without loss of potential workers. Thus, a model in which potential workers of a firm differ in their reservation wage values may generate wage dispersion.

Recently, the theoretical and empirical literature on equilibrium search has made substantial progress (see Ridder and Van den Berg, 1997, for an overview). The recent literature takes the theoretical framework developed by Mortensen (1990) and Burdett and Mortensen (1998) as points of departure. In this framework, ex ante identical workers are allowed to search for other jobs while working. A firm that sets a high wage is then able to attract workers from firms offering lower wages. So, if individuals work at different wages then, from the point of view of an employer, the labor supply curve is upward sloping, and there is a trade-off between the wage and the labor force of the firm, which in turn generates equilibrium wage dispersion. In the case of homogeneous workers and firms, the equilibrium wage density is increasing, which is at odds with the data. Therefore, to be able to fit wage data, it is necessary to account for heterogeneity. Van den Berg and Ridder (1998) deal with this by assuming that the labor market is segmented and consists of a large number of separate different submarkets within which workers and employers are homogeneous. Here, the productivity level can be interpreted as the worker-specific skill level. This model is well able to explain wage data. Moreover, it allows for structural unemployment: if the minimum wage or the opportunity cost of employment exceeds the productivity level of a segment then all workers attached to that segment become permanently unemployed (or non-participant). However, the policy effects on unemployment within a single segment or market are trivial, in this model as well as in the Diamond (1971) model and the homogeneous Burdett-Mortensen (1998) model, as well as in model extensions with heterogeneous firms *within* a market (Bontemps, Robin and Van den Berg, 2000). All unemployed workers accept all job offers all the time. If the common minimum wage or benefits level increases, then the wage distribution shifts towards higher wages, and unemployment does not change. This is restrictive; for example, concerning minimum wage effects, there is no consensus on their size and magnitude. In addition, these models do not explain negative duration dependence of the aggregate exit rate out of unemployment, which is an important stylized fact, and they do not allow individuals within the same market to have different benefits levels.

This obviously calls for heterogeneity of unemployed workers' benefits levels within a market. Mortensen (1990), Burdett and Mortensen (1998) and Bontemps, Robin and Van den Berg (1999) examine this model extension. Heterogeneity in benefits levels implies that workers with high benefits levels reject some job offers, so that a part of the frictional unemployment is due to workers' selectivity. Moreover, the policy effects are non-trivial, and the aggregate exit rate out of unemployment displays negative duration dependence.

In this paper we adopt the model framework developed by Van den Berg and Ridder (1998) (see also Koning, Ridder and Van den Berg, 1995), and we extend this with benefits heterogeneity. That is, we assume that the labor market is segmented and consists of a large number of separate different submarkets within which workers have the same productivity but possibly different benefits levels. Different segments have different productivity levels. From the above it follows that this model allows for frictional and structural unemployment, it can be expected to give a good fit to data on wages and unemployment durations, and it does not impose trivial policy effects.

Since we allow for unemployment benefits dispersion and we intend to examine counterfactual benefits distributions, we have to be specific about the benefits system and the determinants of the individual benefits level. Over the years the unemployment benefits system has become a complicated system of income protection for workers who have lost their job. Its core is the unemployment insurance system that was introduced after World War II. Unemployment insurance benefits protect workers, in particular workers with insufficient savings, during their search for a new job. Without this protection workers would be forced to accept jobs at a much lower wage than they earned in their last job. In the wage posting model that is the basis for our empirical work, unemployment insurance benefits increase the correlation between the wage in the new job and the value of the (marginal) product of the worker.

The unemployment insurance systems differ considerably between countries. The main differences are in the requirements for eligibility, the duration of benefits, and the replacement rate, i.e. the ratio of the benefits to income in the job that was lost. In most countries these benefits support job search up to a year. The replacement rate is at most 70% of previous income, but in many cases much lower. In some countries the replacement rates are needs based, being higher for couples with a single earner. In most countries unemployment insurance benefits are supplemented by other types of benefits. Many countries have unemployment assistance benefits for unemployed who exhaust their unemployment insurance benefits. These are usually not a fraction of previous income and often means tested. Often supplements are paid to single-earner households and/or households with children and this increases the replacement rates for these households.

In some countries the supplements are paid as housing benefits. An additional complication is that some countries also have a social assistance program that supports individuals and households that do not qualify for unemployment insurance or assistance benefits, and social assistance benefits usually act as a lower bound on unemployment benefits.

This complicated system of income protection for the unemployed leads to a substantial variation in replacement rates between types of households, but surprisingly not between countries (with a few exceptions) and over the duration of the spell of unemployment. In a comparison of 18 countries, the OECD found that at the average wage, unemployment insurance benefits replaced on average 52% of previous gross earnings, irrespective of household type (OECD, 1997). The net (of tax) replacement rates including supplemental benefits for a couple with children was on average 73% in the first month of unemployment and 67% after 5 years of unemployment.[1] The decline in the replacement rate during the unemployment spell is larger for couples without children and single-person households, but smaller for couples with children who earned a wage below the average.

We conclude that (i) although the unemployment insurance benefits decline during the spell of unemployment, the supplemental benefits make this decline less pronounced, and (ii) replacement rates differ between household types. In fact, we will assume that, for a given household type, the unemployment income is essentially constant during the spell of unemployment. Van den Berg (1990) shows that it is optimal for unemployed workers to anticipate future declines of the benefits level by reducing the reservation wage before the actual decline. As a result, the optimal reservation wage path declines less than might be expected on the basis of the magnitude of the benefits declines. The reservation wage is generally close to the constant reservation wage level in a stationary model where the benefits level is an average of the actual successive levels during a spell.

In principle, it would be preferable to incorporate any benefits declines into the equilibrium model. Due to their complexity, such models have not been analyzed in the literature. The path of the optimal reservation wage follows a differential equation that cannot be solved analytically except for special functional forms for the wage offer distribution. The labor supply of a firm at a given point of time is affected by the cross-sectional distribution of reservation wages across unemployed individuals who are at different stages of their spells. It is not clear what the equilibrium properties are. Perhaps more importantly, from a computational point of view, the empirical analysis of such models seems

[1] The exception is Italy with a 11% replacement rate after 5 years.

extremely complicated.

We should note that in general a constant benefits level does not correspond to the socially optimal outcome. For example, in the context of a frictional labor market, Hopenhayn and Nicolini (1997) show that an optimal benefits system entails that benefits decline during unemployment. However, investigations of the effects of decreasing benefits and the socially optimal system are beyond the scope of this paper.

In our empirical work we take account of the variation of benefits between household types. In many countries the unemployment insurance (but not the unemployment or social assistance) benefits are related to the income in the last job. This provides a second source of variation in unemployment benefits. In our model we ignore this type of variation. In developing our model we shall argue that this variation may influence wage setting at higher wages. However, we want to concentrate on the lower end of the labor market where the disincentive effects of the benefits system are more important. To avoid biases, we estimate the model for a country, the UK, in which the insurance benefits are not related to previous earnings.

The high replacement rates for particular types of households have led to concern that work is hardly attractive to members of such households. Such households are caught in an unemployment trap, which may translate into a poverty trap. An important contribution of this paper is to quantify this unemployment trap. It is important to do this in an equilibrium model of the labor market, because this allows us to distinguish between the case that job seekers turn down offers and the case that it is not profitable for firms to employ workers at their reservation wage. The unemployment trap refers to the first case, because in the latter the unemployed do not receive any job offers. If this case applies, the jobs "just are not there", as often stated by frustrated job seekers.

A policy intervention that makes work more attractive is the introduction of benefits that are conditional on employment. Examples are the Earned Income Tax Credit in the US and the Family Credit in the UK. As we shall show, in a wage posting model these benefits have the same effect as a reduction in the unemployment benefits. In our empirical work, we shall estimate the effect of the Family Credit on labor market outcomes, taking account of the responses of employers. Hence, our work supplements earlier studies of the FC that only considered labor supply responses (Scholz, 1996). When the FC was introduced some critics expressed concern that it would be an implicit wage subsidy to low-wage employers (OECD, 1997). We shall quantify this effect.

Full estimation of equilibrium search models with longitudinal labor force survey data is a non-trivial task and requires data of high quality covering long time spans, as is obvious from the empirical studies above. Such data are not readily available for every country. In this paper we show that the structural model parameters can be estimated from aggregate data that are obtained from yearly cross-sectional surveys (such as the US Current Population Survey (CPS) and the EC Labor Force Surveys (LFS); these aggregate data are obtained from readily available OECD and EUROSTAT publications). This may come as a surprise, since equilibrium search models deal with interrelations between duration and wage variables, while aggregate data only contain information on the marginal distributions of wages, benefits, and durations.

Estimation with readily available aggregate data is useful if longitudinal micro data are not available or if the scope of a study does not allow estimation with micro data. The approach is therefore particularly useful for cross-national comparisons. Moreover, given the high requirements of the quality of longitudinal micro data and the relatively small number of observations and high attrition rate in most of those data, estimates from aggregate data derived from repeated cross-sections provide a useful comparison.

The paper is organized as follows. The next section presents the theoretical model. Section 3 describes the institutional aspects of the benefits and income tax system, and it discusses the data. The empirical implementation is discussed in section 4 and the estimation results are in section 5. Section 6 discusses the policy evaluations of our paper. Finally, section 7 summarizes our main findings,

2 The equilibrium search model

2.1 Submarkets

We assume that the labor market can be segmented into a large number, to be precise a continuum, of submarkets. In a submarket workers with a common productivity, i.e. a common marginal value product, denoted by p interact with firms that are identical, except for the size of their workforce. The distribution of productivity levels over the submarkets is given by the cdf I'. We assume that workers and firms can not move between segments. Hence, we may think of p as an endowment, e.g. related to specific skills of workers that are required by a specific group of firms or the level of productivity at a particular location where a group of workers and firms are stuck, and not as a characteristic that can be changed by investment by either the worker, e.g. in schooling, or the firm, e.g. in capital goods. Alternatively, we may think of p as a characteristic that can be changed by investment. In that case, we assume that all investment decisions have been made, and no further investment takes place. In our empirical work, we do not relate p to observed characteristics of workers and/or firms, so that the distinction is moot.

2.2 Workers

Every worker in a particular submarket is either unemployed or employed. If unemployed he or she receives unemployment benefits that depend on the type of household that he or she belongs to. Household types are denoted by $h = 1,\ldots, H$ and the unemployment benefits of a worker in household type h is denoted by b_h. The income tax rate also depends on h and b_h is the after-tax benefits. The household type only affects the unemployment benefits and the income tax rate and is not related to any other characteristic of the worker or firm as used in the model. In particular, we assume that the distribution of p is the same for workers belonging to different household types. If the total mass of workers is normalized to 1, then $m_h, h = 1,\ldots, H$ is the fraction of workers who belong to household type h. Without loss of generality we order household types by increasing net benefits.

Jobs arrive according to a Poisson process, with arrival rate λ, which is the same for employed and unemployed workers. The assumption that the job offer arrival rate is the same in employment and unemployment deserves some discussion. If we relax this assumption then the model becomes intractable, because then the unemployed workers' reservation wages depend on all structural determinants (see Mortensen, 1990). Moreover, the currently available aggregate data are often not informative on the job offer arrival rate of the employed (Ridder and Van den Berg, 1999). Of course, the assumption we make is restrictive. Other empirical studies based on equilibrium search models either find that the arrival rates are of similar magnitude (see e.g. Van den Berg and Ridder, 1998) or find that the arrival rate of job offers to employees is an order of magnitude smaller than that of unemployed job searchers (Kiefer and Neumann, 1993, and Bontemps, Robin and Van den Berg, 2000). The only other studies in which equilibrium search models with benefits dispersion have ever been estimated assume either that employed workers receive offers at the same rate as the unemployed (Bontemps, Robin and Van den Berg, 1999) or that they do *not* receive alternative offers (Eckstein and Wolpin, 1990). The latter model does not fit the wage data well.

Employed workers become unemployed at a separation rate 6. In the remainder of this paper, we write κ to represent the ratio X/6. This parameter can be interpreted as the average number of job offers during a spell of employment. Workers maximize their expected future wealth, discounted at a rate ρ.

When a job is offered to a worker, this worker has to decide whether to accept or reject the job. Since jobs have just one characteristic, the wage level, the optimal strategy depends only on that level and it has the reservation wage property. If there are no job mobility costs, the reservation wage of employed individuals is equal to the wage in their current job. Because the offer arrival rate of an unemployed worker remains the same if he or she accepts a job, the after-tax reservation wage is equal to the after-tax unemployment benefits. The computation of the before-tax reservation wage is complicated by employment-conditional benefits as the Earned Income Tax Credit (EITC) in the US and the Family Credit (FC) in the UK. These are determined by the net income in the job. If the reservation wage is denoted by ξ_h, then the net reservation wage is equal to $\xi_h - \tau_h(\xi_h)\xi_h$ with τ_h the tax schedule. The corresponding tax credit is denoted by d_h. The net income in the job is the sum of these components, and this is equal to net income while unemployed b_h. Hence, the reservation wage is the solution of $\xi_h - \tau_h(\xi_h)\xi_h + d_h = b_h$.

Note that an employment-conditional tax credit is equivalent to the reduction of the after-tax unemployment benefits by the value of the tax credit. The reservation wage decreases with the tax credit and in this sense the introduction of the credit can be seen as a painless (to the unemployed) reduction of the unemployment benefits. If the marginal tax rate is less than 100%, then it always pays to accept a job with a higher wage. Because in our model we do not consider the hours decision and workers always supply either 0 or a fixed number of hours, the behavior of employed workers is unaffected by the tax system. For that reason, it is convenient to use before-tax quantities in the model. The only place where the tax system plays a role is in the determination of the reservation wage of the unemployed.

2.3 Firms

We define $l(w|p)$ as the steady-state workforce of a firm offering a gross wage w given that it operates in the submarket with productivity level p. The gross wage is the before-tax wage, but after social security contributions. The latter is innocuous, if we interpret p as the value product after deduction of this contribution An increase in this contribution shifts the distribution of p and could lead to a higher level of structural unemployment as defined below. We do not consider social security contributions in the sequel. Employers are assumed to maximize their steady-state profit flow

$$\pi(w|p) = (p - w)\, l\,(w|p) \tag{1}$$

The employers' optimal strategy has two stages. First, they decide whether to participate or not and next, if they decide to participate, they make a wage offer. We assume that the same wage must be offered to all members of the workforce of a firm. For the moment, we assume that there is no mandatory minimum wage. It is obvious that $l(w|p) = 0$, whenever $w < \xi_1$, i.e. below the lowest reservation wage of the unemployed, and firms offering wages below ξ_1 do not participate in their labor submarket. Hence, the optimal strategy is to participate if and only if the productivity level is higher than the lowest reservation wage level. The distribution of the wages offered in a submarket is represented by a distribution function $F(w|p)$. The support of the wage offer distribution is equal to the set of profit maximizing wages, which we denote by w(p). The infimum and supremum of the support are denoted by $\underline{w}(p)$ and $\overline{w}(p)$. Note that the strategy of firms is a pure strategy if and only if $F(w|p)$ is degenerate. The earnings distribution, i.e. the distribution of wages earned by a cross section of workers at a point in time, is denoted by $G(w|p)$.

2.4 Equilibrium in a submarket

For a particular submarket, the model as described in the previous subsections, is a special case of Mortensen's model. We assume that there is no productivity dispersion in submarkets and that the job offer arrival rates are the same for employed and unemployed workers. Mortensen (1990) shows that the equilibrium wage offer distribution is given by

$$F(w|p) = \min_{x \geq w} \varphi(x|p) \tag{2}$$

with

$$\varphi(w|p) = \frac{1+\kappa}{\kappa}\left(1 - \sqrt{\frac{(p-w)\sum_{w \geq \xi_h} m_h}{(p - \underline{w}(p))\sum_{\underline{w}(p) \geq \xi_h} m_h}}\right) \tag{3}$$

The density of the wage offer distribution is equal to

$$f(w|p) = \begin{cases} \varphi'(w|p) & \text{if } w \in \mathcal{W}(p) \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

where $\mathcal{W}(p) = \{w|\varphi(w|p) \leq \varphi(x|p), \underline{w} \leq x \leq \overline{w}(p)\}$ and $\varphi'(w|p)$ is the derivative of the function φ

$$\varphi'(w|p) = \frac{1+\kappa}{2\kappa} \frac{1}{\sqrt{(p-w)(p-\underline{w}(p)) \sum_{w \geq \xi_h} m_h \sum_{\underline{w}(p) \geq \xi_h} m_h}} \tag{5}$$

Since employers, who offer a wage in an interval below the reservation wage of a particular type of workers, are able to increase their profits by offering a wage equal to that reservation wage, there will be no wage offers in that interval and the density $f(w|p)$ is 0 in an interval below the ξ_h's. The lowest wage offered in a submarket depends on p. This wage is always equal to the reservation wage of some type of worker. As shown by Mortensen, the type is given by $\arg\max_{h=1,\ldots,H} \left\{(p - \xi_h) \sum_{k=1}^{h} m_k\right\}$.

The steady-state equilibrium earnings distribution is

$$G(w|p) = \frac{\kappa \sum_{w \geq \xi_h} m_h u_h(p) \left(F(w|p) - F(\xi_h|p)\right)}{\left(1 + \kappa \overline{F}(w|p)\right)(1 - u(p))} \tag{6}$$

where $\overline{F} = 1 - F$ and $u_h(p)$ is the equilibrium unemployment rate for type h workers with productivity level p

$$u_h(p) = \frac{1}{1 + \kappa \overline{F}(\xi_h|p)} \tag{7}$$

And $u(p)$ is the unemployment rate for all workers with productivity level p

$$u(p) = \sum_{h=1}^{H} m_h u_h(p) \tag{8}$$

By taking derivatives of equation (6), we obtain the density of the earnings distribution

$$g(w|p) = \frac{\kappa \sum_{w \geq \xi_h} m_h u_h(p) f(w|p)}{(1 + \kappa \overline{F}(w|p))^2 (1 - u(p))} \tag{9}$$

Analytical expressions can be derived for the conditional distributions $F(w|p)$ and $G(w|p)$ after tedious calculations. See the Appendix for more details.

The preceding discussion did not allow for the presence of a mandatory minimum wage. A few comments are in order. First, we use the notation w_{min} for such a minimum wage and $\bar{\xi}_h := \max\{w_{min}, \xi_h\}$. Second, its introduction has the consequence that firms in a labor market segment only participate if their productivity level is at least as high as $\bar{\xi}_1$. Third, the new wage offer distribution first order stochastically dominates the wage offer distribution before the introduction of a minimum wage. Fourth, even if the minimum wage is binding in the sense that $\underline{w}(p) < w_{min}$ before its introduction, it is possible that this minimum wage is not in the support of the wage offer distribution. In that case the introduction of the mandatory minimum wage makes the lowest wage equal to the largest reservation wage below the minimum wage that has positive support. Finally, the introduction of a minimum wage does not have any effect if it is below the lowest reservation wage.

2.5 Aggregation over submarkets

The macro labor market wage offer distribution is derived by aggregation over the distribution of p (*cf.* Koning, Ridder and Van den Berg, 1995)

$$
\begin{aligned}
F(w) &= \int F(w|p)d\Gamma\,(PIP \geq \bar{\xi}_h) \\
&= \int_{p\in\mathcal{W}^{-1}(w)} F(w|p)d\Gamma\,(PIP \geq \bar{\xi}_h) + \Gamma\left(\underline{p}(w)|p \geq \bar{\xi}_1\right)
\end{aligned}
\tag{10}
$$

The function $\underline{p}(w)$ is the inverse of the upper bound of the support of the wage offer distribution $\overline{w}(p)$ seen as a function of p (analogously $\overline{p}(w)$ is the inverse function of the lower bound of the support $\underline{w}(p)$). Because the cdf of the wage offer distribution is equal to 1 if the wage exceeds this upper bound, integration over those values of p that are consistent with a given value of w yields the second term in the last equation. See figure 1 for an illustration. $\mathcal{W}^{-1}(w)$ is the inverse of the support of the wage offer distribution, i.e. those values of p for which the wage offer density $f\,(w \mid p) > 0$ for a given value of w.

The aggregate wage offer density function f is given by

$$
f(w) = \int_{p\in\mathcal{W}^{-1}(p)} f(w|p)d\Gamma(p|p \geq \bar{\xi}_1) \tag{11}
$$

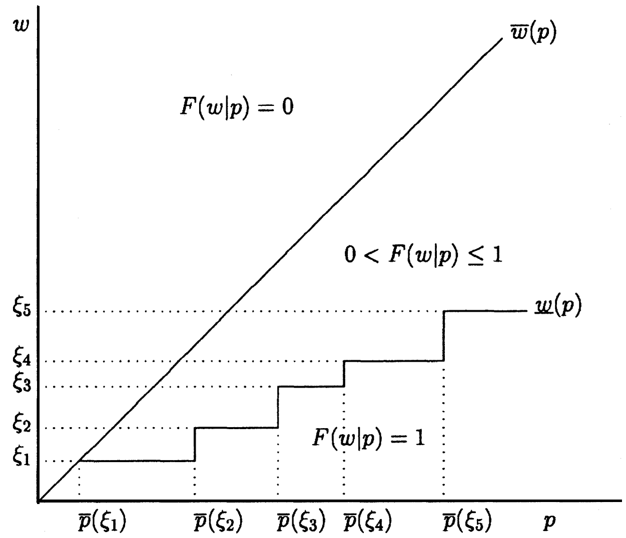


Figure **1:** Illustration of the relationship between wages, productivity levels and the conditional wage offer distribution

The aggregate unemployment rate is given by

$$u = \sum_{h=1}^{H} \int \frac{m_h}{1+\kappa \overline{F}(\xi_h|p)} d\Gamma(p) = \frac{1}{1+\kappa} \sum_{h=1}^{H} m_h \overline{\Gamma}(\overline{p}(\overline{\xi}_h)) +$$
$$\sum_{h=1}^{H} \int_{\underline{p}(\overline{\xi}_h)}^{\overline{p}(\overline{\xi}_h)} \frac{m_h}{1+\kappa \overline{F}(\xi_h|p)} d\Gamma(p) + \sum_{h=1}^{H} m_h \Gamma(\underline{p}(\overline{\xi}_h)) \tag{12}$$

The first term on the right-hand side applies to submarkets in which all offered wages are acceptable to the unemployed. The second term refers to submarkets where some but not all offers are acceptable to the unemployed, while the third term is for submarkets where none of the wage offers are acceptable.

The assumption that the arrival rates are the same among transition states, together with the finite number of household types and as a consequence the discrete distribution of unemployment benefits, implies that all the submarket wage offer distributions have intervals with zero density below the reservation wages (that are independent of p). Hence the aggregate wage offer and earnings distributions have zero density on the same intervals. This is clearly a less attractive feature of the equilibrium distribution. We will not try to mask it by introducing measurement error in the wages.

2.6 A decomposition of unemployment

It is illustrative to introduce a decomposition of the unemployment rate into a structural and frictional part. This decomposition can be obtained by using formula **(12)** of the previous subsection. First, the structural unemployment rate, which is the third component on the right-hand side of (12), can be decomposed as

$$\sum_{\xi_h < w_{min}} m_h \Gamma(\underline{p}(w_{min})) + \sum_{\xi_h > w_{min}} m_h \Gamma(\underline{p}(\xi_h)) \tag{13}$$

The first component is the structural unemployment due to a high minimum wage. This component is equal to zero if $\xi_1 \geq w_{min}$, i.e. if the lowest reservation wage exceeds the minimum wage. The second component consists of structural unemployment due to high reservation wages, i.e. firms with a productivity below the reservation wage of some group of unemployed workers make offers that are not acceptable to these workers who prefer to remain unemployed. We denote these two components of structural unemployment by $u^s_{w_{min}}$ and u^s_b. These components are not independent: a lower minimum wage gives less unemployment due to a high minimum wage, but more unemployment due to high reservation wages.

The frictional component of unemployment is equal to the sum of the first two terms on the right-hand side of **(12)**

$$\frac{1}{1+\kappa}\sum_{h=1}^{H} m_h \overline{\Gamma}(\overline{p}(\overline{\xi}_h)) + \sum_{h=1}^{H}\int_{\underline{p}(\overline{\xi}_h)}^{\overline{p}(\overline{\xi}_h)} \frac{m_h}{1+\kappa\overline{F}(\overline{\xi}_h|p)} d\Gamma(p) \tag{14}$$

The first component consist of unemployment in submarkets where the unemployed of various types accept all job offers. The second component corresponds to submarkets where some of the unemployed turn down job offers.

3 Institutions and data

3.1 Unemployment benefits and income taxes

In the United Kingdom, unemployment insurance benefits are independent of income in the last job. If the unemployed worker is eligible for UI benefits, he or she receives these benefits for **1** year after a waiting period of 3 days. The benefit amount depends on the household situation and is equal to 338 dollars per month for single individuals and lone parents and equal to 547 dollars per month for couples.

There is no unemployment assistance for unemployed who exhaust their UI benefits. However, there is a social assistance system for all households whose net income falls below a minimum level and whose members do not work more than 16 hours per week (Income *Support*). In the calculation of the benefit amount the net income of the household from labor and other sources is taken into account. These maximum benefits are equal to 338 dollars per month for single individuals and 532 dollars per month for couples. Supplements are paid for dependent children, depending on the age of the child. These supplements vary from 116 dollars per month for a child under 11 to 268 dollars per month for a child above 18 years of age.

In addition the household receives housing benefits that are equal to the rent for households who are eligible for *Income Support*. For non-eligible households, housing benefits are equal to the rent minus 65 percent of the difference between net income and the maximum benefit.

Finally, family benefits are paid to households with children below 15 years of age or below 19 if they are still in full-time non-advanced education. The benefits are equal to 76 dollars per month for the eldest child and 62 dollars per month for each additional child.

Household members are taxed individually. The marginal tax rate is progressive and varies from 20 to 40 percent. An important feature of the tax system in the United Kingdom is the existence of an earned income tax credit for adults *(Family credit)*. The actual payments from this in-work benefits system depend on the number of children, the age of the children and net income. For adults with two children (one below 11 and one between 11 and 15), the payments are equal to 490 dollars per month at the level of the minimum wage. This is quite a large amount compared to the level of unemployment benefits in the United Kingdom.

3.2 The data on unemployment durations and wages

The unemployment data are from the UK Labor Force Survey (LFS), which is part of the EUROSTAT LFS, and which is held every quarter. The EUROSTAT LFS combines surveys from different EU member states and is designed to obtain comparable labor force statistics of the different countries. It is intended to cover all persons whose usual place of residence is in the territory of the EU. From 1992, the methods and definitions of the surveys are harmonized across countries (see EUROSTAT, 1996a, for a summary). We therefore restrict attention to data from the years 1992 to 1996. EUROSTAT publishes the results of the surveys in their annual report (see for example EUROSTAT, 199613). For the UK, the annual report uses data from the Labor Force Survey of the second quarter of the year. These are not corrected for any seasonal effects. The sample size of the Survey differs from period to period, but is on average equal to about 60,000 households.

We use unemployment rate data from these annual EUROSTAT reports. The corresponding unemployment definition is based on the IL0 definition (i.e., self-reported: without work, actively searching, and immediately available for work). We also use the unemployment duration data from these annual reports. These concern the elapsed durations of currently unemployed individuals. Specifically, the durations are grouped into eight duration classes: < 1 month, 1 – 3, 3 – 6, 6 – 12, 12 – 18, 18 – 24, 24 – 48 and $\geq$ 48 months, and we observe the number of individuals who are in a certain duration class. The duration is defined as the minimum of the duration of search for a job and the length of the period since the last job was held.

Data on earnings are based on the annual New Earnings Survey, provided by the British Central Statistical Office. The survey concerns a 1% random sample of employees in Pay As You Earn (PAYE) schemes. This gives about 180,000 records in each year of our reference period. The data that we use are grouped, and they concern gross earnings of full-time employees. These gross earnings equal what the worker formally earns: they include occasional payments but exclude employer labor taxes.

The tax rates at different wage levels are obtained by using data of the OECD (1997). These tax rates equal income taxes plus social security contributions minus benefits provided to employees, such as housing benefits and family benefits. We take the differences between household types into account. Figure 2 illustrates the calculated average tax rates.

Table 1 provides some descriptive statistics for the year 1994. As there was no mandatory minimum wage in the UK in 1993, we use the smallest of the minimum wages that are set by the wage councils.

Structurally unemployed individuals may be underrepresented in the unemployment data. Structurally unemployed individuals will never find a job, so they may classify themselves as a nonparticipant when being questioned on their labor market state. Some of them may be in the disability program or in early retirement even though they are still able and willing to work. As a result, the unemployment rate in the data may underestimate the total unemployment rate,

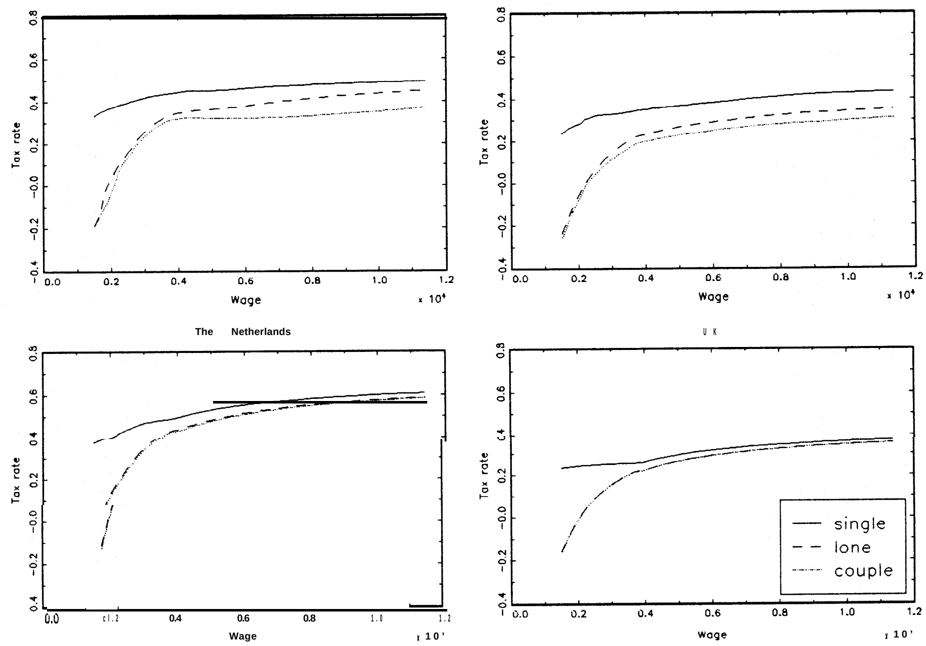


Figure 2: Average tax rates at different wage levels, in local currency

and the estimated structural unemployment may be downward biased. This problem cannot be solved by adding all nonparticipants to the unemployed, because the state of nonparticipation also includes individuals who do not participate by choice, e.g. homemakers. The current data do not enable a distinction between individuals who do not participate by choice and individuals who would participate if the wage floor were not binding. Previous empirical research found that the group of non-participants is quite heterogeneous and these individuals differ from the unemployed with respect to their transition rate to employment (Flinn and Heckman, 1983, Gönül, 1992, and Jones and Riddell, 1999). We report the UK non-participation rate in Table 1. This rate is high in comparison to other countries. It has to be stressed that it varies across different age groups.

3.3 Construction of the unemployment benefits distribution

The benefits data provided by OECD (1997) are our starting point for the construction of the distribution of b in the population. These data concern calculated after-tax unemployment benefits for different types of households conditional on the occasion that the head of the household receives either unemployment insurance or social assistance. It is important to stress that these calculations are

Variable	
Unemployment	
Unemployment rate	0.097
Fraction with duration > 1 year	0.45
Fraction with duration > 2 years	0.27
Fraction with duration > 4 years	0.10
Wages (earnings) [a]	
Minimum wage in 1993 [b]	745
Mean wage in 1995	2358
Kaitz index [c]	0.32
D5/D1-ratio	1.78
D9/D5-ratio	1.86
D9/D1-ratio	3.31
Average replacement rate in 1993 [b]	0.63
Marginal wedge	0.40
Non-participation	
Non-participation rate, age 20-65	0.30

[a] Gross levels, in U.S. dollars per month. Di is the i th decile of the earnings distribution.
[b] Source: Central Planning Bureau (1995).
[c] The Kaitz index is defined as the ratio of minimum wage and average earnings, see Dolado et al. (1996).

Table 1: Some descriptive statistics for 1994.

basically made for every worker in the labor force, so that the averages correspond to the average worker and not to the average currently unemployed worker. If calculations would be based on currently unemployed workers only then corrections for selectivity would have to be made to obtain the population distribution. The benefits levels include supplementary housing and family benefits. The calculations are provided for 1995. OECD (1997) distinguishes three prototypes of households: (1) single persons, (2) lone parents with two children, and (3) married couples with two children. Table **2** summarizes these data.

We use the EUROSTAT LFS to translate these benefits by household level into the benefits distribution at the individual level. Table 114 of EUROSTAT (199613) presents numbers of private households by household type. Members of a household who are under **15** years of age are counted as children, while members aged above 15 are counted as adults. Hence, it is not unusual to find households with 3 or more adults. The LFS distinguishes 5 main types of households: (1) one person households, (2) several adults and no children (3) one adult with children, **(4)** two adults and children and (5) three or more adults and children. Note that the fourth category contains households with two parents and children below 15 as well as one-parent families with one of the children being 15 years or older. In Table **115** of EUROSTAT (1996b), the activity rates by household type are summarized. These give the number of household members in the labor force divided by the total number of adults within the household type, for each household type.

We obtain the benefits distribution over individuals by using the information of the two tables mentioned above. First, we multiply the number of households in each household type by the size of each type. This gives the number of individuals with a given household type. Note that we have to split up the second category mentioned above, since this category represents both two-adult households and three-or-more-adult households. We use a family size of 3.37 in the case of a household of size three or more. It turns out that the sensitivity of the estimation results with respect to this assumption is small. The constructed benefits distribution does not change very much even if we use a value of 5 or 6. Secondly, we multiply the numbers of individuals in the different household types by the corresponding activity rates. This results in a distribution for the five main household types described above. Now, recall that OECD (1997) only allows for three household types. We categorize individuals in households with two or more adults as single. Moreover, we merge the fourth and fifth category to obtain the category of households with children.

Some of these assignments are rather ad hoc. In the empirical analysis we

	Unempl. Insurance			Social Assistance		
	Single	Lone Parent	Couple	Single	Lone Parent	Couple
Benefits level	765	948	1111	765	1110	1265

Table 2: After-tax benefits levels of different household types, in U.S. dollars per month.

Variable	
Single	968
Lone parent	-352
Couple with children	127

Table 3: Gross reservation wages in U.S. dollars per month for the year 1994

perform sensitivity analyses to investigate to what extent the results are sensitive with respect to this.

As noted in the introduction, we assume that for a given household type, unemployment income is constant during the spell of unemployment. Here, we operationalize this by taking the relevant benefit level to be a weighted average of the two successive benefit levels given in OECD (1997). The weights are the percentage of unemployed with a duration less than two years and the percentage with a duration of more than two years. We examine the sensitivity of the results with respect to this assumption. Figure 3 illustrates the resulting distributions of b. The second category (lone mothers) constitutes a small fraction of the labor force. This could be sensitive to the EUROSTAT (1996b) classification of household types, which does not allow for a separation of parents from other adults. It is possible that a fraction of the household categories (2), (4), and (5) are actually also one-parent families.

By invoking the relation $(1 - \tau_h(\xi_h))\xi_h + d_h = b_h$, we obtain the distribution of (gross) reservation wages from the benefits distribution. Table 3 presents this for the year 1994. The reservation wage for lone parents is negative. This is a direct result of the *Family Credit*. By comparing the reservation wages to the minimum wage (see Table 1), it follows that structural unemployment is partly due to high unemployment benefits (namely, for single living individuals) and partly due to the minimum wage (namely, for individuals in other household types).

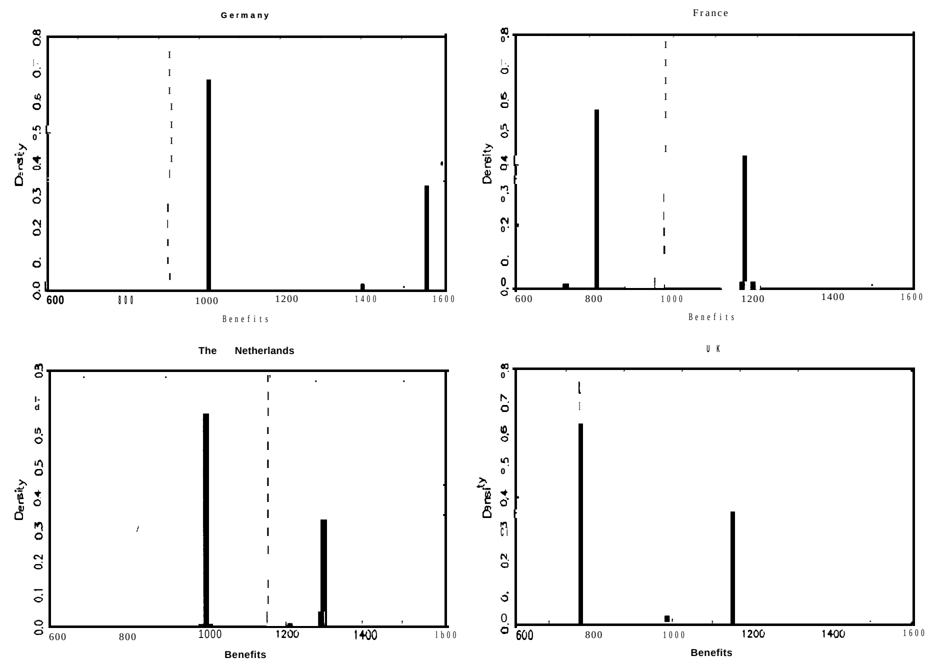


Figure 3: Distribution of benefits levels among different household types for the year 1994

4 The empirical implementation

4.1 The likelihood function

Since we allow for three different benefits levels, we estimate the model of section 2 with $M = 3$. Recall that we have three sets of endogenous variables. First, for individuals in the LFS sample who are in the labor force we observe whether they are unemployed or employed. Secondly, for unemployed individuals in the LFS sample we observe the elapsed unemployment duration. Thirdly, for individuals in the earnings sample we observe the wage. When deriving the likelihood function, we interpret the samples as random samples of individuals from the corresponding populations. The stochastics that is used to estimate the model ultimately comes from the randomness of the arrival times of events and the randomness of the contacts between workers and employers. The distribution of these sources of randomness is an essential ingredient of the individual's decision problem.

Let us examine the distributions of each of the three sets of endogenous variables. The marginal probability of unemployment is equal to u, which is obtained by using equation **(12).** Hence, whether a randomly chosen individual is unemployed or not is determined by a Bernoulli distribution with this parameter u.

We define $\Psi(t)$ as the distribution function of elapsed unemployment durations in the stock of unemployed, and Q(t) as the corresponding survivor function Note that $\alpha = \overline{\Psi}(\infty)$. Individuals who are frictionally unemployed have an outflow rate given p of $\lambda\overline{F}(\overline{\xi}_h|p)$; $h \in \{1, \ldots, H\}$. As a result,

$$\overline{\Psi}(t) = \alpha + \frac{1}{u}\sum_{h=1}^{H}\int_{\underline{p}(\overline{\xi}_h)}^{\overline{p}(\overline{\xi}_h)} \frac{m_h}{1+\kappa\overline{F}(\overline{\xi}_h|p)} e^{-\lambda\overline{F}(\overline{\xi}_h|p)t} d\Gamma(p) + \frac{1}{u}\frac{1}{1+\kappa}e^{-\lambda t}\sum_{h=1}^{H} m_h\overline{\Gamma}(\overline{p}(\overline{\xi}_h)) \tag{15}$$

The value of α is determined by equation (13). Note that if the benefits distribution is degenerate, $\overline{\Psi}(t)$ reduces to $\alpha + (1-\alpha)e^{-\lambda t}$. In that case, α and λ can be estimated directly from the unemployment duration data. In any case, the probability that an unemployed individual is in the duration class $[t_{i-1}, t_i)$ is equal to $\Psi(t_i) - \Psi(t_{i-1}) = \overline{\Psi}(t_{i-1}) - \overline{\Psi}(t_i)$. These probabilities define the grouped unemployment duration distribution, which is a multinomial distribution.

By analogy to equation (10), the distribution of earnings (i.e., cross-sectional wages) equals

$$G(w) = \int_{p\in\mathcal{W}^{-1}(p)} G(w|p)d\Gamma(p|p \geq \overline{\xi}_1) + \Gamma\left(\underline{p}(w)|p \geq \overline{\xi}_1\right) \tag{16}$$

The probability that an employed individual has a wage which falls in the earnings class $[w_{i-1}, w_i)$ is equal to $G(w_i) - G(w_{i-1})$. These probabilities define the grouped earnings distribution, which is a multinomial distribution. Note that the use of grouped data makes our estimation method, to some extent, robust against outliers in the wage data.

We maximize the following log likelihood function, in notation to be explained below,

$$\log L = N_1 \log u + N_2 \log(1-u) + \sum_{i=1}^{C_t} N_{1,i} \log\left(\overline{\Psi}(t_{i-1}) - \overline{\Psi}(t_i)\right) + \sum_{i=1}^{C_w} N_{3,i}\log\left(G(w_i) - G(w_{i-1})\right) \tag{17}$$

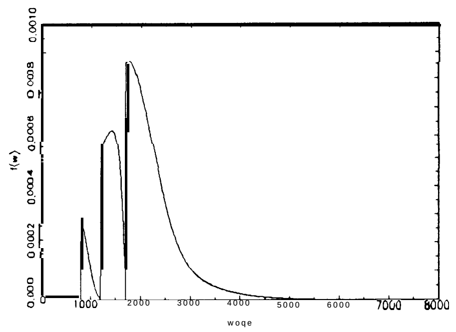
where C_t and C_w represent the number of duration and earnings classes, N_1+N_2 is the total number of individuals in the sample for the unemployment rate, with N_1 the number of unemployed, and $N_{1,i}$ is the number of unemployed with a duration in the i^{th} class, so that, obviously, $N_1 \equiv \sum N_{1,i}$. Furthermore, $N_{3,i}$ is the number of individuals in the sample for the earnings distribution with earnings in the i^{th} class. Moreover, the t_i's and w_i's are the threshold values of the duration classes and earnings classes, respectively, where we use the conventions $t_0 = w_0 = 0$ and $t_{C_t} = w_{C_w} = \infty$. The values of N_1, N_2, and $N_{1,i}$ can be straightforwardly calculated from the number of households in the Labor Force Survey, using the average number of adults per household by household type and the activity rates by household type. Note that in Ψ (equation (15)) we integrate with respect to $d\Gamma(p|u=1)$.

Of course, we have to substitute the structural expressions for $F(w|p)$ and $G(w|p)$ into the above expressions. The parameterization of the productivity distribution is discussed in the next subsection.

4.2 Choice of the productivity distribution

In our empirical work the distribution of p is chosen to give a good fit to the observed wage distribution. First, it should be noted that with a discrete distribution of unemployment income b, both the wage offer and the earnings distributions will have zero density in an interval below each reservation wage. This is true irrespective of the choice of the distribution of p. The empirical wage distribution does not have such gaps. There are two reasons why we think that this feature of the equilibrium distribution does not invalidate our estimates. The first reason is that the discrete distribution of b is a discretization of a continuous distribution that we do not observe. In principle, it is possible to generate such a continuous distribution using a microsimulation model that computes for every, and not just the unemployed, participant in the labor market his or her unemployment income. Unfortunately, we do have access to such a model. The second reason is that we use grouped wage data. In such data the gaps, which turn out to be small for well-fitting distributions of p, are not visible. As long as the empirical fractions are fitted, we do not worry too much about the shape of the wage density within the intervals.

For the value of κ that is consistent with the duration data, the wage offer distribution is concentrated near the maximum wage in a submarket. This implies that the right tail of the wage offer and earnings distributions will resemble the productivity distribution. In figure 1 we give the earnings density for a pro-



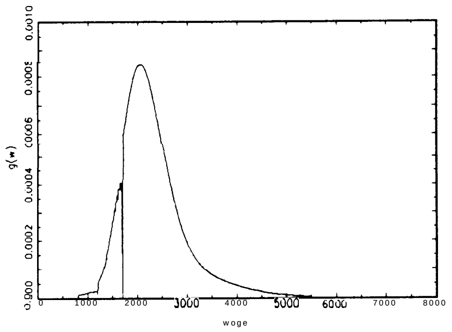


Figure 4: Wage offer and earnings density, using a mixture of log normal distributions, $f(x) = \pi \log N(\mu_1, \sigma^2) + (1 - \pi) \log N(\mu_2, \sigma^2)$, $\lambda = 0.07$, $\delta = 0.006$, $\mu_1 = 7.7$, $\mu_2 = 8.2$, $\sigma = 0.2$ and $\pi = 0.9$

Quantile	With dispersion	Without dispersion
1%	1309	1315
5%	1522	1517
10%	1665	1645
20%	1828	1813
30%	1958	1945
40%	2079	2065
50%	2200	2187
60%	2332	2319
70%	2490	2476
80%	2706	2692
90%	3111	3095

Table 4: Quantiles of the earnings density with and without benefits dispersion

ductivity distribution that is a mixture of two lognormal distributions. This class of productivity distributions is able to fit the observed wage data.

In Figure 5 we illustrate the effect of benefits dispersion on the shape of the earnings density. We choose again a mixture of two lognormals for the distribution of p. We consider two cases (i) a three point distribution for b with points of support 800, 1200 and 1600, and corresponding probabilities 0.25, 0.5 and 0.25, and (ii) a degenerate distribution of b concentrated in 1200, i.e. the mean of the three point distribution. The effect of the benefits dispersion is restricted to the lower tail of the earnings density. This is confirmed by the quantiles of the two distributions reported in table 4.

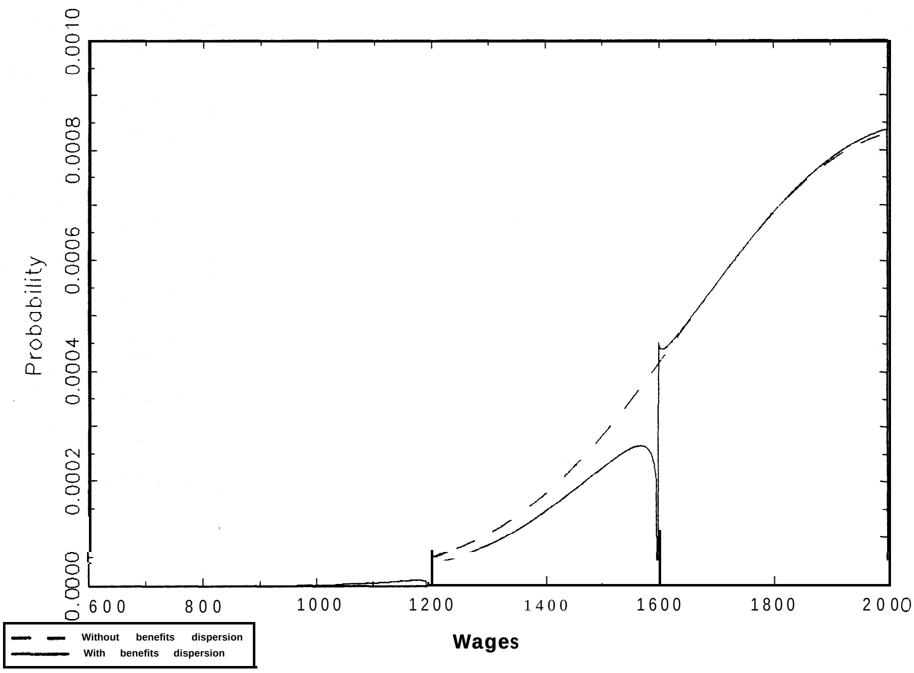


Figure **5:** Illustration of the effects of benefits dispersion

4.3 A sampling experiment

In our empirical work, the estimates are based on large data sets. **However,** the data are grouped, and the model is a highly nonlinear mixture. **To** see what precision we may expect, we perform a sampling experiment. We only report the results for a single choice of the parameters. The number of observations is 10000, and the unemployment durations and wage s are grouped in 5 and **18** intervals as in the observed data. The distribution of the reservation wage has three points of support 600, 1200 and 1700 with probabilities 0.6, 0.2, and 0.2.

The parameters λ and δ are set to **0.07** and **0.006.** Furthermore, the productivity distribution is a mixture of lognormals with means 7.7 and 8.2, and common standard deviation 0.2. The minimum wage is not binding, i.e. lower than the smallest reservation wage. The corresponding values of α, $u_s^{w_{min}}$ and u^f are equal to 0.1658, 0, and 0.0874.

In table 5, we report the results of 1000 replications. Apart from the parameters μ_1, μ_2 and α, the theoretical standard deviations have quite similar values as the empirical standard deviations. As can be seen from figure 6, the fitted wage and duration distributions are are very well predicted.

Variable	Mean value	Empirical std. of mean	Theoretical std. dev.	Std. dev. std. dev
Parameters of the model				
λ	0.0703	0.0003	0.0032	0.0034
μ_1	7.6949	0.0003	0.1000	0.0035
μ_2	8.1960	0.0017	0.0996	0.0173
σ	0.2058	0.0003	0.0023	0.0030
δ	0.0060	0.0000	0.0003	0.0003
π	0.9029	0.0009	0.0067	0.0086
κ	11.7533	0.0446	0.3938	0.4458
Decomposition of unemployment				
a	0.1833	0.0009	0.1227	0.0092
u_f	0.0870	0.0003	0.0027	0.0030

Table 5: Results of the monte carlo simulation

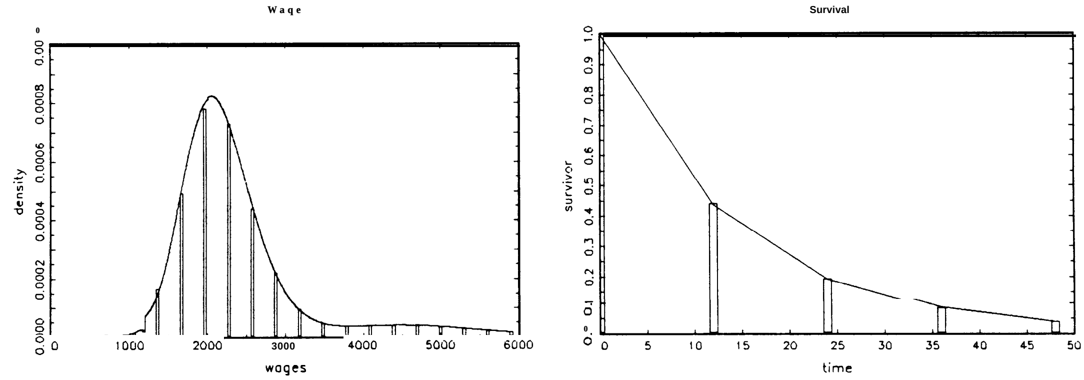


Figure 6: Estimated earnings density and survivor function of the Monte Carlo simulations

Variable	1992	1993	1994	1995	1996
Parameters of *the model*					
λ	***0.0994***	0.0774	***0.0709***	0.0772	0.0877
	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
μ_1	***7.5093***	7.5678	***7.5789***	7.5851	7.5768
	(0.1440)	(0.1887)	(0.1820)	(0.2036)	(0.2079)
μ_2	8.1679	8.2538	8.2620	8.2488	8.2402
	(0.1430)	(0.1866)	(0.1800)	(0.2011)	(0.2051)
σ	0.2914	0.3125	0.3147	0.3340	0.3328
	(0.0062)	(0.0062)	(0.0067)	(0.0089)	(0.0092)
δ	0.0102	0.0086	0.0073	0.0068	0.0072
	(0.0001)	(0.0001)	***(0.0001)***	(0.0001)	(0.0001)
π	***0.7197***	0.7624	0.7561	0.7410	0.7359
	(0.0275)	(0.0282)	(0.0300)	(0.0399)	(0.0416)
κ	***9.7060***	8.9978	***9.6753***	11.3363	12.2130
	(0.1316)	(0.1187)	(0.1318)	(0.~628)	(0.1803)
Decomposition *of* ***unemployment***					
Total unemployment	0.0974	0.1037	0.0972	0.0857	0.0805
	(0.0050)	(0.0056)	(0.0052)	(0.0069)	(0.0073)
Str. unempl. by min. wages	0.0004	0.0004	0.0004	0.0007	0.0007
	(0.0010)	(0.0012)	(0.0011)	(0.0018)	(0.0020)
Str. unempl. by unempl. ben.	0.0037	0.0034	0.0033	0.0042	0.0044
	(0.0039)	(0.0044)	(0.0040)	(0.0051)	(0.0053)
Frictional unemployment	0.0931	0.0997	0.0934	0.0807	0.0753
	(0.0012)	(0.0012)	(0.0012)	(0.0011)	(0.0011)

* ***Standard errors are between parentheses***

Table 6: Estimation results

5 The results

We estimate the model for 1992-1996. We consider five years to check whether the parameters are relatively stable over time. The results are summarized in table 6. It is found that the parameter estimates do not vary too much over the years.

The parameter estimates can be used to decompose the unemployment rate. It is found that only about 7% of total unemployment is structural, and that most of the structural unemployment is due to high reservation wages. The remainder of total unemployment is due to search frictions.

The fit of the earnings and unemployment duration distributions is reported

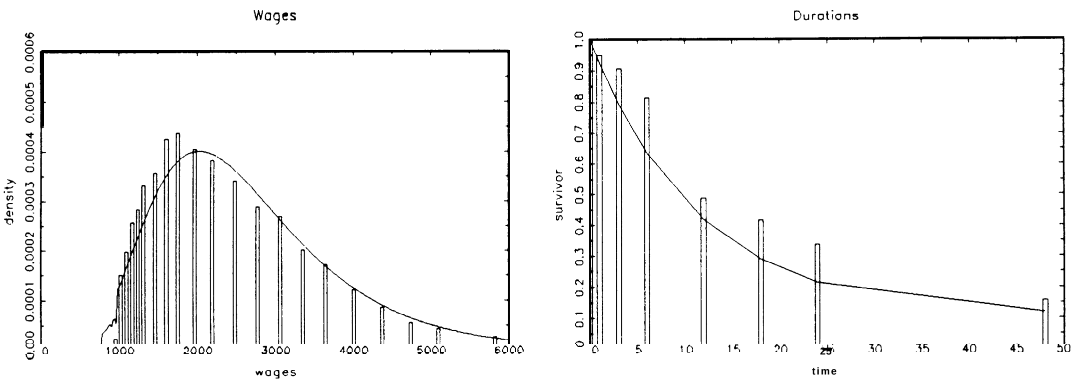


Figure 7: Estimated and observed earnings density and survivor function of the year **1996**

Variable	Estimate
Earnings distribution	
Mean earnings level	**2134**
Standard deviation	**1312**
Productivity distribution	
Mean productivity level	**2556**
Standard deviation	**1058**

Table 7: Mean and standard deviation of wage and productivity distribution

in figures 7. Although we do not observe the unemployment duration distribution by household type, the model predicts that there is a relation between type and duration. In table 8 we report the fraction unemployed after **12, 24,** and 36 months. Single workers are predicted to have longer unemployment durations than workers in other household types. This effect is only due to the higher reservation wage of single workers.

A weak point in our empirical analysis is concerned with the assumptions that were made in obtaining the unemployment benefits distribution. It seems hard to evaluate the quality of this distribution, but it is possible to analyze the impact of the different assumptions that were made. For example, we made the assumption that the relevant benefit level is a weighted average of the social assistance and unemployment insurance levels. However, individuals are expected to decrease their reservation wages long before the date of unemployment insurance exhaustion. Additionally, since our model is stationary, there is some space for

	Fraction
After 12 months	
$\overline{\Psi}(12\|\text{"single"})$	0.4828
$\overline{\Psi}(12\|\text{"lone"})$	0.4336
$\overline{\Psi}(12\|\text{"couple"})$	0.4336
After 24 months	
$\overline{\Psi}(24\|\text{"single"})$	0.2601
$\overline{\Psi}(24\|\text{"lone"})$	0.1917
$\overline{\Psi}(24\|\text{"couple"})$	0.1917
After 48 months	
$\overline{\Psi}(48\|\text{"single"})$	0.1233
$\overline{\Psi}(48\|\text{"lone"})$	0.0442
$\overline{\Psi}(48\|\text{"couple"})$	0.0442

*** *Standard errors are between parentheses***

Table 8: Fraction unemployed of the different household types after 12, 24 and 48 months

misspecification in the sense that for structurally unemployed people only the social assistance level is important. This might change the conclusions that the minimum wages did not explain any unemployment at all. Therefore, we looked at the impact of using the social assistance level instead of the weighted average of both kinds of benefit levels. Our second investigation of sensitivity was concerned with the distribution of household types. The results of the previous section were based on the assumption that households with two adults living together obtain the same benefits as single individuals. This seems to be a rather realistic assumption for the United Kingdom. However, on some grounds one might imagine that it is better to classify them in the same group as the couples with children (for example because of future decisions in household composition). As a final investigation, we looked at the effect of ignoring the group of lone parents in our analysis. We found that the results do not change very much for all these cases.

6 Policy evaluation

For a sophisticated evaluation of possible changes in policy, it is important to realize that it is not sufficient to look at measures like total and structural unemployment only. It is also important to look at the effect of total welfare in the economy. Eckstein and Wolpin (1990) use a social welfare function to analyze this effect. Following these authors, we define the macroeconomic welfare function as follows:

$$\mathcal{S} = m_1 \int_{p(\max\{\xi_1, w_{min}\})}^{\infty} p d\Gamma(p) + m_2 \int_{\underline{p}(\max\{\xi_2, w_{min}\})}^{\infty} p d\Gamma(p) + m_3 \int_{\underline{p}(\max\{\xi_3, w_{min}\})}^{\infty} p d\Gamma(p)$$

Note that our welfare function differs from the welfare function of Eckstein and Wolpin (1990) by the exclusion of the individual non-monetary value of leisure. On the other hand, together with the welfare function of Eckstein and Wolpin (1990), the monetary value of leisure (b) does not appear in our welfare function. This is valid only in the case that benefits are pure income transfers between different groups of the populations. If there is a balanced budget and if the difference in taxes due to the changes in benefits is not raised on wages or is completely burdened by individuals with high wages, then this is indeed the case. According to our model, the increase in taxes does not influence the labor market participation decision for these individuals. We note that our welfare function measures total production within the economy, which seems to be an objective measure of welfare. We also take changes in the budget of the policy maker into account.

Our first exercises in policy evaluation concern an increase and a decrease of 10% of all benefits. Note that the effects of an increase and a decrease are not completely opposite, since it depends on the productivity distribution and the initial situation. Additionally, we note that a policy evaluation based on a decrease of benefits is a bit tricky, since it is based on the left tail of the productivity distribution for which we do not have any data. This means that it is not possible to observe what individuals would have earned if they would have been working. Additionally, we are interested in what happens if all reservation wages are equal to those with the highest reservation wage. In that case, there is no dispersion of reservation wages anymore. The final policy implementation is somewhat similar to the third with the only difference that we analyze the case in which all reservation wages are equal to the average level of the reservation wage. This means that reservation wage for all individuals is equal to 471 dollars. The estimate of $\mathcal{S}$ with respect to the original policy is equal to 2542.

From the results of table 9, it is found that the increase of 10% of benefits resort quite large effects on both structural and total unemployment. A decrease of all benefits resorts the opposite effects. An increase of all reservation wages equal to the highest reservation wage is found to have less effects than an overall increase. Additionally, we find that the costs of such a method are quite high. A policy change that makes all reservation wages to become equal to the average level of the reservation wages resorts similar results as a 10% reduction of all benefits. However, the reduction in the benefits budget is smaller.

As stated in the introduction, we also look at the effects of the present system of the Family Credit (FC) in the United Kingdom. We do this by looking at predicted outcomes of our model, when such is system was not present. Table 10 summarizes the results. It is found that the structural unemployment rate is increased a lot compared to the case where the FC is present, while total unemployment does not increase that much. Additionally, it is found that the costs of the present system are about 16 dollars per month per inhabitant. Although these costs are quite high, it is found that they are outweighed by the change in unemployment benefit payments.

7 Conclusions

This paper analyzes unemployment benefits systems of the United Kingdom. In particular, we are interested in the effects of benefits and the mandatory mini-

Variable	Estimate
Level of social welfare	
10% increase of all unemployment benefits	2543
10% decrease of all unemployment benefits	2545
All benefits equal to highest benefits	2539
All benefits equal to mean benefits	2546
Unemployment level	
10% increase of all unemployment benefits	0.1071
10% decrease of all unemployment benefits	0.0962
All benefits equal to highest benefits	0.1024
All benefits equal to mean benefits	0.0947
Structural unemployment level	
10% increase of all unemployment benefits	0.1294
10% decrease of all unemployment benefits	0.0287
All benefits equal to highest benefits	0.0939
All benefits equal to mean benefits	0.0116
Change in benefits budget	
10% increase of all unemployment benefits	16
10% decrease of all unemployment benefits	-12
All benefits equal to highest benefits	45
All benefits equal to mean benefits	-5

Table 9: Results of the policy simulations for the year 1994

Variable	Estimate
Level of social welfare	2523
Total unemployment level	0.1251
Structural unemployment level	0.2523
Costs of the present EITC	15.7
Increase in outlays for benefits	22.9

Table 10: Results of the EITC policy evaluation

mum wage on structural and frictional unemployment. Our model is based on an equilibrium search model which allows for differences in unemployment benefits as well as productivity levels and job-to-job transitions. We use readily available aggregate data, published by the OECD (1997) and EUROSTAT (1996). Our estimation method is structural and we use a maximum likelihood approach. The estimated structural parameters are the friction parameters and the parameters of the aggregate productivity distribution. Different components of the unemployment rate are directly obtained from the parameters.

Data of benefit levels are not available at the aggregate level. Therefore, we construct this distribution by the calculation of the benefit level conditional on the household type and the distribution of individual workers among these different household types. Frictional unemployment seems to be insensitive to policy parameters, but structural unemployment varies substantially across different policy regimes.

References

Bontemps, C., J.M. Robin and G.J. van den Berg (1999), An empirical equilibrium job search model with search on the job and heterogeneous workers and firms, ***International** Economic Review 40,* Forthcoming

Bontemps, C., J.M. Robin and G.J. van den Berg (2000), Equilibrium search with continuous productivity dispersion: theory and non-parametric estimation, ***International Economic Review*** 40, Forthcoming

Burdett, K. and D.T. Mortensen (1998), Wage differentials, employer size and unemployment, *International Economic Review 39, 257-273*

Central Planning Bureau (1995), ***Replacement rates, a transatlantic overview,*** CPB working papers 80, Central Planing Bureau

Devine, T.J. and N.M. Kiefer (1991), ***Empirical Labor Economics: The Search Approach,*** Oxford University Press

Diamond, P.A. (1971), A model of price adjustment, ***Journal** of **Economic Theory,*** 3, 156-168

Dolado, J., F. Kramarz, S. Machin, A. Manning, D. Margolis and C. Teulings (1996), The economic impact of minimum wages in Europe, *Economic Policy* 23, 319-372

Eckstein, Z. and K.I. Wolpin (1990), Estimating a market equilibrium search model from panel data on individuals, *Econometrica 58, 783-808*

EUROSTAT (1996a), *Labour **Force Survey, Results*** 1996, Office for Official Publications of the European Communities, Brussels

EUROSTAT (1996b), ***The European Union** labour **force survey. Methods and definitions, Office*** for Official Publications of the European Communities, Brussels

Flinn, C.J. and J.J. Heckman (1983), Are unemployment and out of the labor force distinct labor force states, ***Journal** of **Labor Economics*** 1, 28-42

Gönül, F. (1992), New evidence on whether unemployment and out of the labor force are distinct states, ***Journal** of **Human Resources 27,*** 329-361

Hopenhayn, H.A. and J.P. Nicolini (1997), Optimal unemployment insurance, ***Journal** of **Political Economy*** 105, 412-438

Jones, S.R.G., and W.C. Riddell (1999), The measurement of unemployment: an empirical approach, ***Econometrica 67,*** 147-162

Kiefer, N.M., and G.R. Neumann (1993), Wage dispersion with homogeneity: The empirical equilibrium search model, in N.C. Westergaard-Nielsen and P. Jensen, ***Proceedings of the third symposium on panel data and labor market dynamics,*** North-Holland, Amsterdam

Koning, P.W.C., G. Ridder and G. J. van den Berg (1995), Structural and frictional unemployment in an equilibrium search model with heterogeneous agents, ***Journal of Applied Econometrics*** 10, S133–S151

Layard, R., S. Nickel1 and R. Jackman (1991), Unemployment: macroeconomic performance and the labour market, Oxford University Press

Mortensen, D.T. (1986), Job search and labor market analysis, ***in*** 0. Ashenfelter and R. Layard, ***Handbook of Labor Economics*** 2, North-Holland, Amsterdam

Mortensen, D.T. (1990), Equilibrium Wage Distributions: A Synthesis, *in* J. Hartog, G. Ridder and J. Theeuwes, ***Panel Data and Labor Market Studies,*** North-Holland, Amsterdam

Mortensen, D.T. and C.A. Pissarides (1999), New developments in models of search in the labor market, ***in:*** 0. Ashenfelter and D. Card, ***Handbook of Labor Economics*** 3, North-Holland, Amsterdam

OECD (1997), ***Making Work Pay,*** OECD, Paris

Ridder, G., and G. J. van den Berg (1997), Empirical equilibrium search models, ***in*** D.M. Kreps and K.F. Wallis, ***Advances in Advances in economics and econometrics: Theory and applications: Seventh World Congress,*** Econometric Society Monographs 28, Cambridge University Press, 82-127

Ridder, G., and G. J. van den Berg (1999), Estimating measures of labor market imperfection in five OECD countries, using aggregate data an equilibrium search framework, Department of Economics, Vrije Universiteit, Amsterdam

Scholz, J.K. (1996), In-work benefits in the United States: the earned income tax credit, ***Economic Journal*** 106, 156-169

Van den Berg, G.J. (1990), Nonstationarity in job search theory, ***Review*** *of* ***Economic Studies 57,*** 255-277

Van den Berg, G. J., and G. Ridder (1998), An empirical equilibrium search model of the labor market, ***Econometrica*** 66, 1183-1221

Wolpin, K.I. (1995), ***Empirical methods*** *for* ***the study*** *of* ***labor force dynamics,*** Harwood Academic Publishers, Luxembourg

Appendix. Analytical solution for $F(w|p)$

It is possible to derive analytical expressions for the wage offer and earnings distributions for any given productivity level p. For convenience, ignore the minimum wage. It is useful to distinguish between seven cases (with corresponding shapes): four in the case $\underline{w}(p) = \xi_1$, two in the case $\underline{w}(p) = \xi_2$ and one in the case $\underline{w}(p) = \xi_3$. It is not very informative to present the solutions for all these cases, so we consider just one case. If $(\xi_3 - \frac{m_1\xi_1}{(1+\kappa)^2})/(1 - \frac{m_1}{(1+\kappa)^2}) < p < \min\{\frac{\xi_3 - m_1\xi_1}{1-m_1}, \frac{(m_1+m_2)\xi_2 - m_1\xi_1}{m_2}, (\xi_3 - \xi_2\frac{m_1}{m_1+m_2})/(1 - \frac{m_1}{m_1+m_2})\}$, then the wage offer distribution is equal to

$$F(w|p) = \begin{cases} 0 & \text{if } w < \xi_1 \\ \frac{1+\kappa}{\kappa}\left(1 - \sqrt{\frac{p-w}{p-\xi_1}}\right) & \text{if } \xi_1 \le w < p - (p-\xi_2)\frac{m_1+m_2}{m_1} \\ \frac{1+\kappa}{\kappa}\left(1 - \sqrt{\frac{p-\xi_2}{p-\xi_1}\frac{m_1}{m_1+m_2}}\right) & \text{if } p - (p-\xi_2)\frac{m_1+m_2}{m_1} \le w < \xi_2 \\ \frac{1+\kappa}{\kappa}\left(1 - \sqrt{\frac{p-w}{p-\xi_1}\frac{m_1}{m_1+m_2}}\right) & \text{if } \xi_2 \le w < p - \frac{p-\xi_3}{m_1+m_2} \\ \frac{1+\kappa}{\kappa}\left(1 - \sqrt{\frac{p-\xi}{(p-\xi_1)}}\right) & \text{if } p - \frac{p-\xi_3}{m_1+m_2} \le w < \xi_3 \\ \frac{1+\kappa}{\kappa}\left(1 - \sqrt{\frac{p-w}{(p-\xi_1)m_1}}\right) & \text{if } \xi_3 \le w < p - \frac{m_1(p-\xi_1)}{(1+\kappa)^2} \\ 1 & \text{otherwise} \end{cases}$$

Its density function equals

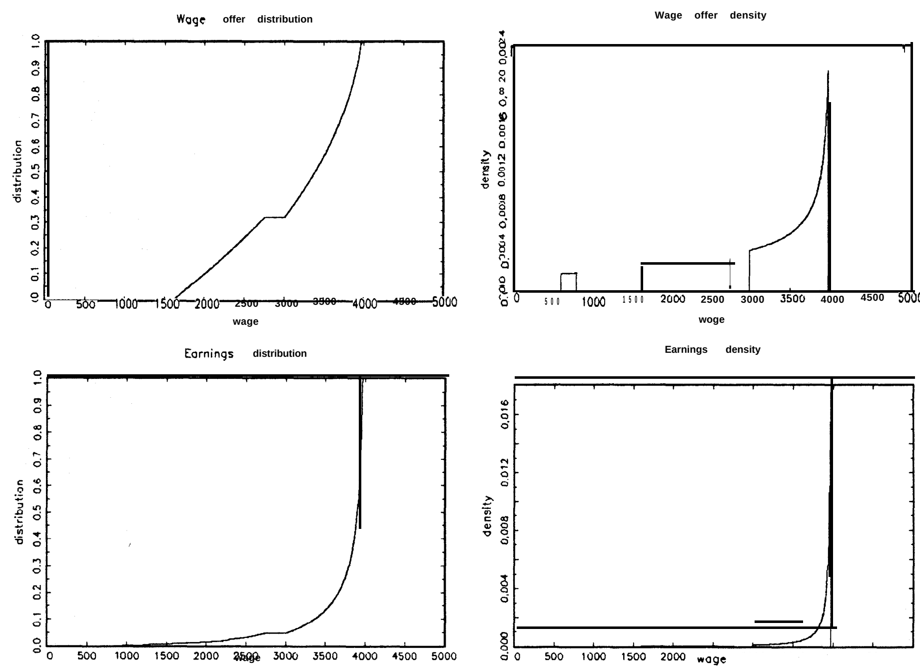


Figure 8: Wage offer distribution and density function, given $p = 4000$, $m_1 = 0.6$, $m_2 = 0.2$, $b_1 = 600$, $b_2 = 1600$, $b_3 = 3000$, $\tau(w) = 0$, $\lambda = 0.04$ and $\delta = 0.006$

$$f(w|p) = \begin{cases} \frac{1}{2\kappa}\frac{1}{\sqrt{(p-w)(p-\xi_1)}} & \text{if } \xi_1 \le w \le p-(p-\xi_2)\frac{m_1+m_2}{m_1} \\ \frac{1}{2\kappa}\frac{1}{\sqrt{(p-w)(p-\xi_1)\frac{m_1}{m_1+m_2}}} & \text{if } \xi_2 \le w \le p-\frac{p-\xi_3}{m_1+m_2} \\ \frac{1}{2\kappa}\frac{1}{\sqrt{(p-w)(p-\xi_1)m_1}} & \text{if } \xi_3 \le w \le p-\frac{m_1(p-\xi_1)}{(1+\kappa)^2} \\ 0 & \text{otherwise} \end{cases}$$

Figure 8 provides a numerical example, displaying $F(w\,|p)$ as well as the corresponding $G(w\,|p)$ and their densities.